SLIMONIPHYLLUM, A NEW GENUS OF LOWER CARBONIFEROUS CORAL FROM BRITAIN

by M. KATO and M. MITCHELL

ABSTRACT. The genus *Slimoniphyllum* is erected with *Rodophyllum slimonianum* Thomson as type species. A new description of the type species is largely based on a series of specimens in the Garwood Collection. The ontogeny, variations, affinities, and distribution of *Slimoniphyllum slimonianum* are discussed.

THE species *Rodophyllum slimonianum* was first described by Thomson (1874, p. 558, pl. 20, fig. 2) from a fragmentary corallite collected by R. Slimon from the lower beds of the Carboniferous Limestone of Scotland (Lower Limestone Group) at Brockley, near Lesmahagow. The species was again figured by Thomson and Nicholson (1876, pl. 1, fig. 1) and redescribed by Thomson (1883, p. 482), but little was added to the original description. Thomson noted the presence of 'more or less clavate and cellular septa, numerous angular dissepiments', and a weak axial structure.

Garwood and Goodyear (1924, p. 261) erected the species *Dibunophyllum rhodophylloides* and *Rhodophyllum distans*, the main distinction between the two being that *D. rhodophylloides* has a weak medial plate. Both species have thickened, vesicular septa, shortened cardinal and counter septa marking prominent fossulae, a weak axial structure, and dissepiments varying from angular and irregular to concentric.

Hill (1939, p. 111) redescribed *R. slimonianum* using Thomson's material, and selected a lectotype for the species. She doubtfully referred the species to the genus *Caninia* but suggested affinities with the Clisiophyllids. In the same monograph (1938–9, pp. 78–79) *D. rhodophylloides* is listed as a synonym of *D. bipartitum konincki* (Edwards and Haime) and *R. distans* as a synonym of *D. bipartitum craigianum* (Thomson).

A re-examination of Thomson's material and the study of specimens in the Geological Survey Museum, London, suggests that the species *slimonianum* belongs to a new genus, and that *D. rhodophylloides* and *R. distans* are synonymous with *slimonianum*. A new genus *Slimoniphyllum* is proposed to include this group of corals, with *R. slimonianum* as the type species.

The possession of an axial structure, often weakly developed, dilated and vesicular septa, and a counter fossula as well as a cardinal fossula, distinguishes *Slimoniphyllum* from *Caninia* Michelin, *Dibunophyllum* Thomson (= *Rodophyllum* Thomson), and *Auloclisia* Lewis. *Auloclisia* is the closest related form and *Slimoniphyllum* is believed to have evolved from it.

The Thomson Collection is housed in the Glasgow Museums and Art Galleries, Kelvingrove, Glasgow, and specimens from this collection have the prefix 'KM.T'. All specimens in the Geological Survey Museum, including the Garwood Collection, have the prefix 'GSM', while 'BM.R' refers to specimens in the British Museum (Natural History).

The authors acknowledge the encouragement and assistance of Dr. H. Dighton Thomas of the British Museum (Natural History), and of Dr. F. W. Anderson and the other officers of the Palaeontological Department of the Geological Survey during the preparation of this paper. Mr. Kato has had

[Palaeontology, Vol. 4, Part 2, 1961, pp. 280-91, pls. 35-36]

the constant encouragement of Prof. M. Minato of the Hokkaido University, and acknowledges a British Council Scholarship during the tenure of which this work was carried out. Mr. M. Mitchell publishes with the permission of the Director of the Geological Survey and Museum. Our thanks are given to Mr. C. E. Palmar of the Glasgow Museums and Art Galleries, for the loan of the lectotype, and Dr. C. L. Forbes of the Sedgwick Museum, Cambridge, for the loan of a celluloid peel taken from the lectotype. The photographs are the work of Mr. J. M. Pulsford and Miss H. Seymer of the Geological Survey.

SYSTEMATIC DESCRIPTION

Class ANTHOZOA Ehrenberg 1834
Order RUGOSA Milne Edwards and Haime 1850
Family AULOPHYLLIDAE Dybowski 1873
Subfamily AULOPHYLLINAE Dybowski 1873
Genus SLIMONIPHYLLUM nov.

Type species. Rodophyllum slimonianum Thomson 1874

Diagnosis. Simple, ceratoid to trochoid rugose coral, with a weak axial structure in which the medial plate tends to degenerate, and the thin septal lamellae tend to become twisted. The septa are dilated in the tabularium and are commonly vesicular (with spaces to one side of the medial line). The cardinal fossula is marked by the shortening of the cardinal septum, is open and parallel sided, and is situated on the convex side of the corallite. A counter fossula is also present, indicated by the shortening of the counter septum, but is less conspicuous than the cardinal fossula. The dissepiments vary from concentric to angular and irregular. The tabulae are flat and complete in the young stages, but later become incomplete and inclined upwards towards the loose axial structure.

Distribution. The genus is at present only known from the Midland Valley of Scotland, the north of England and Derbyshire, where it occurs in beds of high Viséan age (including the D_2 Subzone, P_2, and Coral Zone 3).

Slimoniphyllum slimonianum (Thomson)

Plates 35 and 36

1874 *Rodophyllum Slimonianum* Thomson, p. 558, pl. 20, fig. 2.
1876 *Rhodophyllum Slimonianum* Thomson; Thomson and Nicholson, pl. 1, fig. 1.
1883 *Rhodophyllum Slimoni* (Thomson); Thomson, p. 482.
?1913 *Dibunophyllum muirheadi* Nicholson and Thomson; Garwood, p. 540 (in list only).
1924 *Dibunophyllum* aff. *matlockense* Sibly; Garwood and Goodyear, p. 201 (in list only).
1924 *Dibunophyllum rhodophylloides* Garwood and Goodyear, p. 261, pl. 17, figs. 2*a*, 2*b*.
1924 *Rhodophyllum distans* Garwood and Goodyear, p. 261, pl. 17, figs. 4*a*, 4*b*, pl. 18, fig. 3.
1938 *Dibunophyllum bipartitum konincki* (Edwards and Haime) *pars*; Hill, p. 78.
1939 *Dibunophyllum bipartitum craigianum* (Thomson) *pars*; Hill, p. 79.
1939 *Caninia? slimonianum* (Thomson); Hill, p. 111; 1940, pl. 6, figs. 3, 4.

Lectotype (selected by Hill 1939, p. 111) KM.T 1021 a, b, from the Lower Limestone Group of the Carboniferous Limestone of Scotland (Coral Zone 3 of Hill), at Brockley, Lesmahagow.

Diagnosis. As for genus.

Description. External characters. The corallite is simple, large, and varies in shape from ceratoid to trochoid. The lectotype is a fragment of a large corallite with a diameter greater than any other individual seen, i.e. 5·6 cm. The longest corallite measures more than 10 cm. along its convex side, excluding the tip which is not preserved. The surface is ornamented with fine transverse striae and weak septal grooves; interseptal ridges are present in some corallites. No root-like projections are visible. The calice is deep, its walls are moderately steep and a calicular boss is formed at the centre, except when the Caninioid stage is developed. The cardinal fossula is situated on the convex side of the corallite. Rejuvenescence occurs in some specimens.

Internal characters. (*a*) in transverse section: the corallite is smooth in outline and the wall thin. Both major and minor septa are straight except occasionally in the late stages when they are crenulate in the dissepimentarium; they consist of fibres diverging from

---

EXPLANATION OF PLATE 35

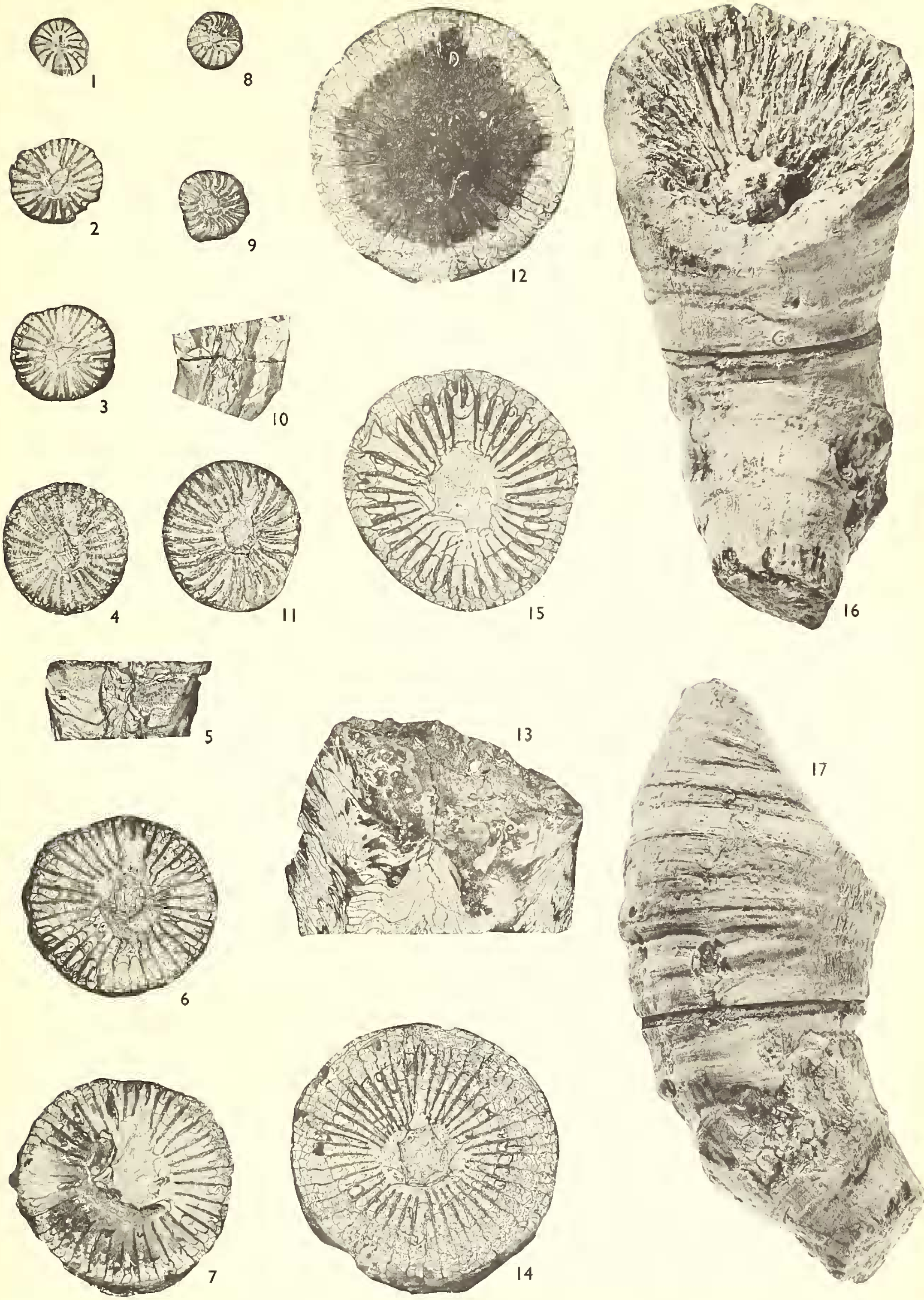
Figs. 1–17. *Slimoniphyllum slimonianum* (Thomson). Natural size. 1–7, GSM 65275, coral bed in Lower *Lonsdaleia* Subzone (D_2), beck above Hunt Pot, 1¼ miles north-east of Horton. 1, 2, Sections A and B, of early neanic stage; 3, 4, sections C and D, of late neanic stage, with dissepiments beginning to develop; 5, section E, L.S. with irregular tabellae and weak axis; 6, 7, sections F and H, major septa are not strongly dilated in the late stages of this specimen and the dissepimental zone is narrow. 8–12, GSM 65277, same locality. 8, 9, Sections A and B, of early neanic stage; 10, section C, L.S. showing irregular tabellae and downward sloping widely spaced tabulae; 11, section D, with weak axis, and thickened major septa (note: dissepiments are late-forming in this specimen); 12, section F, calicular section with thin septa, crenulate in the dissepimentarium. 13, 14, GSM 65288, same locality. 13, Section C, L.S. showing conical tabellae forming axial structures poorly differentiated from tabularium; 14, section A, showing weak axis, short minor septa and wide dissepimentarium. 15–17, GSM 64611, *Lonsdaleia* Subzone (D_2), railway cutting, at Humphrey Head, Grange. 15, Section A, with weak axial column and tapering vesicular septa; 16, 17, calicular and lateral views, showing ornament and external form.

Figs. 1–15 are of celluloid peels. For position of sections see text-figs. 1–8.

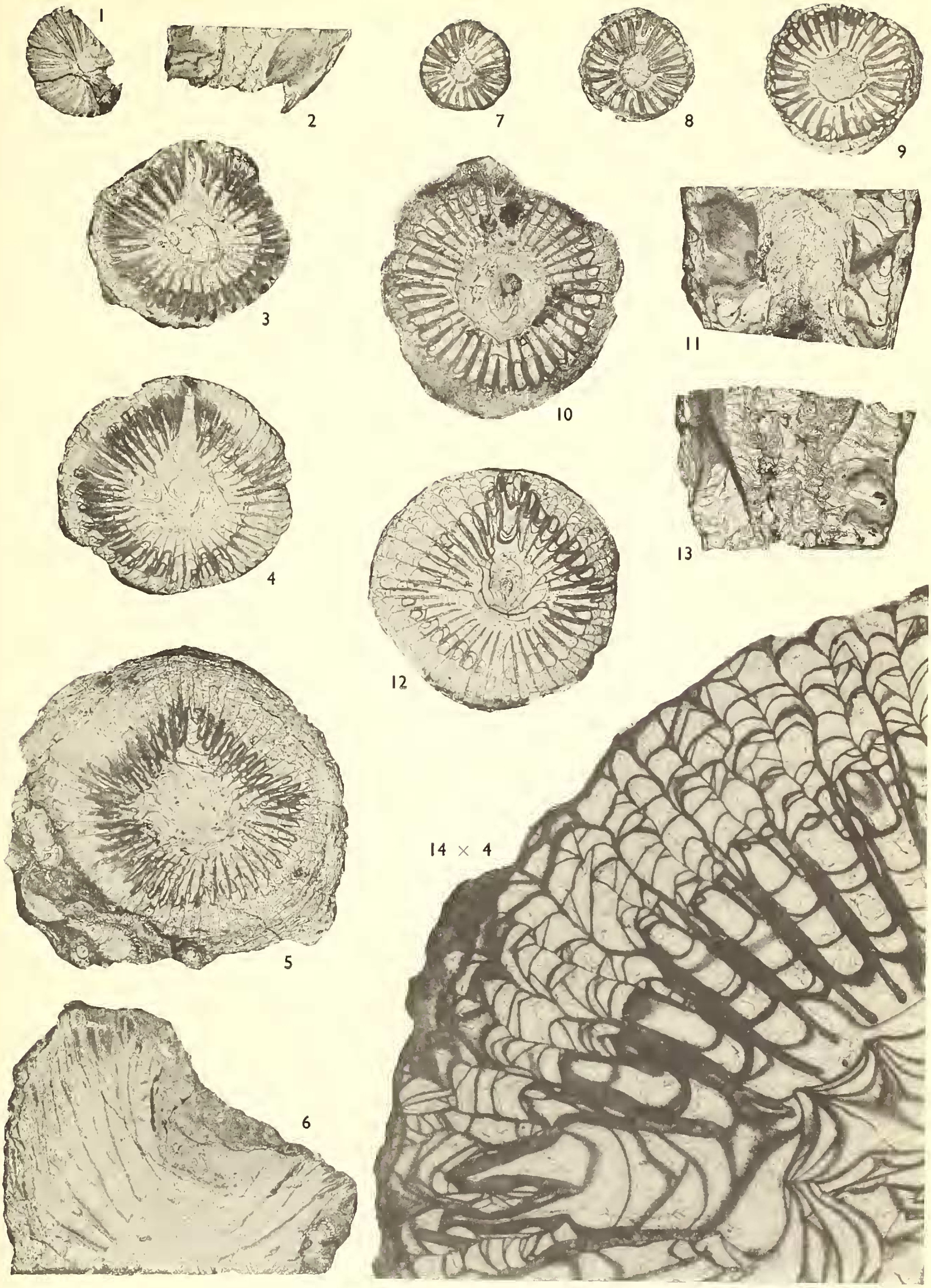
EXPLANATION OF PLATE 36

Figs. 1–14. *Slimoniphyllum slimonianum* (Thomson). 1–6, GSM 101891, ×1, high D_2 of Shining Cliff, 800 yards south-south-west of Matlock Station, showing development of advanced form with weak axial column. 1, Section A, early neanic stage; 2, section B, L.S. with incomplete tabulae raised in the centre to form a weak axial column; 3, section C, late neanic stage; 4, section D, with tapering septa running into axis; 5, section F, with wide, loosely constructed axial column, vesicular septa both bluntly terminate and slightly tapering and wide dissepimentarium with lonsdaleoid dissepiments; 6, section G, L.S. showing caninomorphic features with complete flat tabulae and no axial column in the final stages, and steeply inclined dissepiments. 7–11, GSM 64675, ×1, *Cyathaxonia* shales, *D. muirheadi* Subzone (P_2), Great Rundle Beck, near Dufton. This corallite has a strong, well-defined axial column. 7, Section D, early neanic stage; 8, 9, sections E and G, late neanic stages with dissepiments developing; 10, section K, large strongly defined axis, major septa blunt ended or slightly clavate; 11, section J, L.S. showing well-formed axial column with conical tabellae and weak medial plate, and upward sloping tabulae with gutter formed at outer ends. 12, 13, GSM 65287 section A and 65286 section B, ×1, both from coral bed in Lower *Lonsdaleia* Subzone (D_2), beck above hunt Pot, 1¼ miles north-east of Horton. 12, Shows well-formed axis with short medial plate and straight septal lamellae, vesicular major septa, irregular, angular, crowded inner dissepiments, and concentric outer dissepiments; 13, L.S. with incomplete tabulae, irregular tabellae forming weakly defined axis and large steeply inclined dissepiments. 14, GSM 65291, ×4, holotype of *Dibunophyllum rhodophylloides* Garwood and Goodyear, *P. giganteus* bed (D_2), stream above Dry Lathe Cave, south of Cave Hill (Old Ing) 3½ miles north of Horton. Part of T.S. (PF991), figured by Garwood and Goodyear 1924, pl. 17, fig. 2*a*. Showing details of vesicular septa, axial column with weak medial plate, and arrangement of dissepiments.

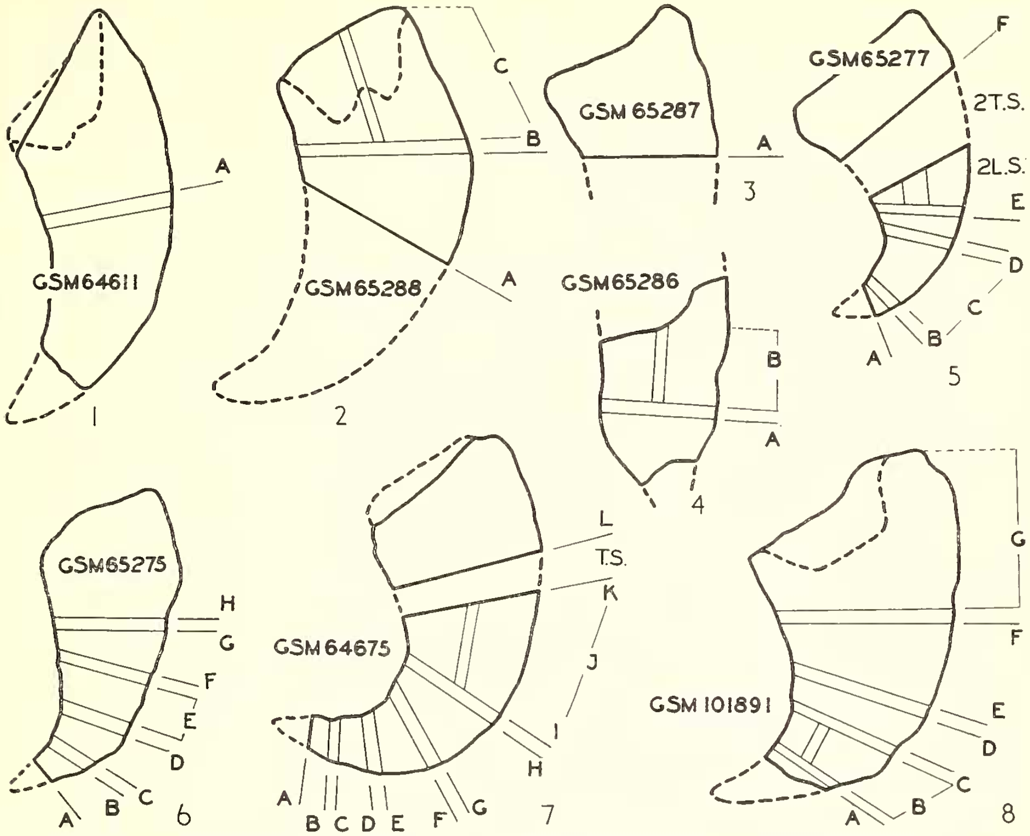
Figs. 1–13 are of celluloid peels; fig. 14 is of a section. For position of sections see text-figs. 1–8.



KATO and MITCHELL, *Slimoniphyllum*



KATO and MITCHELL, *Slimoniphyllum*



TEXT-FIGS. 1–8. Shape and size of specimens of *Slimoniphyllum slimonianum* (Thomson), showing positions from which thin sections and celluloid peels have been taken. Thin sections are referred to as T.S. for transverse and L.S. for longitudinal sections, celluloid peels are referred to by letters. The prefix 'PF' indicates slides in the Geological Survey collection. Details of horizon and locality are given in the section on distribution. 1, GSM 64611, Humphrey Head, 1 peel, A = PF 1018; 2, GSM 65288, Hunt Pot, 2 peels, A and C = PF 1014–15; 3, GSM 65287, Hunt Pot, 1 peel, A = PF 1013; 4, GSM 65286, Hunt Pot, 1 peel, B = PF 1012; 5, GSM 65277, Hunt Pot, holotype of *R. distans*, 2 T.S. = PF 993–4, 2 L.S. = PF 995–6 (PF 993 is figured by Garwood and Goodyear 1924, pl. 17, fig. 4*a*, and PF 995, pl. 17, fig. 4*b*), and 6 peels, A–F = PF 997–1002; 6, GSM 65275, Hunt Pot, 8 peels, A–H = PF 1003–10; 7, GSM 64675, Great Rundle Beck, 1 T.S. = PF 1019 and 12 peels, A–L = PF 1020–31; 8, GSM 101891, Matlock, 8 peels, A, B, B′, C–G = PF 1032–39. All figures ×½.

the central part of the septa (B type of Kato 1959, p. 267). The number of septa is closely related to the diameter of the corallite, and there are forty-four septa of each order at a diameter of 5·6 cm. (see text-fig. 9). The major septa are dilated in the tabularium, but attenuated in dissepimentarium. The axial ends are tapering or bluntly terminated, and occasionally slightly clavate (Pl. 36, fig. 14). Small spaces are often left between the medial line and the dilated part of the septa, giving the septa a vesicular appearance. The cardinal fossula is clearly marked by the short cardinal septum which is about half as long as the other major septa and is situated on the convex side of the corallite. The counter septum is also shortened and is almost two-thirds the length of the others, so that the counter fossula is not so prominent as the cardinal fossula. (Note: the counter quadrants of the lectotype are damaged, and the counter fossula is not seen clearly.) The number of septa in the counter quadrants is usually larger than that in the cardinal quadrants, where dilatation of the major septa is sometimes more pronounced. In the younger stages the minor septa are prolonged into the tabularium where they are slightly dilated, but in the mature stage they are usually attenuated and confined to the dissepimentarium and are occasionally crenulate. The dissepimentarium is wide in the mature corallite, and can be divided into an inner and an outer zone. The dissepiments of the inner zone are angular, irregular, and of the pseudo-herringbone type (i.e. herringbone pattern between major and minor septa, Minato 1955, p. 63). They are also more closely packed than in the outer zone, and this feature, together with the septal dilatation in the tabularium, clearly marks the position of the inner wall.

In the outer zone the dissepiments are less crowded and are more regular and concentric. Narrow concentric lonsdaleoid dissepiments may develop in the outer zone of some mature corallites.

The size and shape of the axial structure are very variable. In some corallites thin septal lamellae, tabellae, and a thin weak medial plate are present, forming a distinct axial column, usually separated from the axial ends of the septa, but with an occasional septal lamella joined to the septa. In other corallites the medial plate is degenerate and the column consists of several weak, thin lamellae together with the axial portions of the incomplete tabulae. This tendency towards degeneration leads in the extreme case to caninomorphs in which no axial structure is present. The axial column in some cases has a distinct border (GSM 64675, Pl. 36, figs. 1–11) and is well differentiated from the tabularium. In other cases the axis is not so clearly differentiated and the septal lamellae are joined to the septa (GSM 101891, Pl. 36, figs. 1–6).

(*b*) In longitudinal section: when the axial structure is strongly developed, it is clearly marked off from the tabularium. The tabellae are closely packed and steeply inclined against the thin medial plate (GSM 64675J, Pl. 36, fig. 11). With degeneration of the medial plate the tabellae become loosely arranged (GSM 65277C, Pl. 35, fig. 10). In some cases the axial structure may degenerate until it only consists of the slightly elevated axial parts of the incomplete tabulae, bound together with a few lamellae (GSM 65286B, Pl. 36, fig. 13). When the axial structure is absent the tabulae are flat and complete (GSM 101891G, Pl. 36, fig. 6).

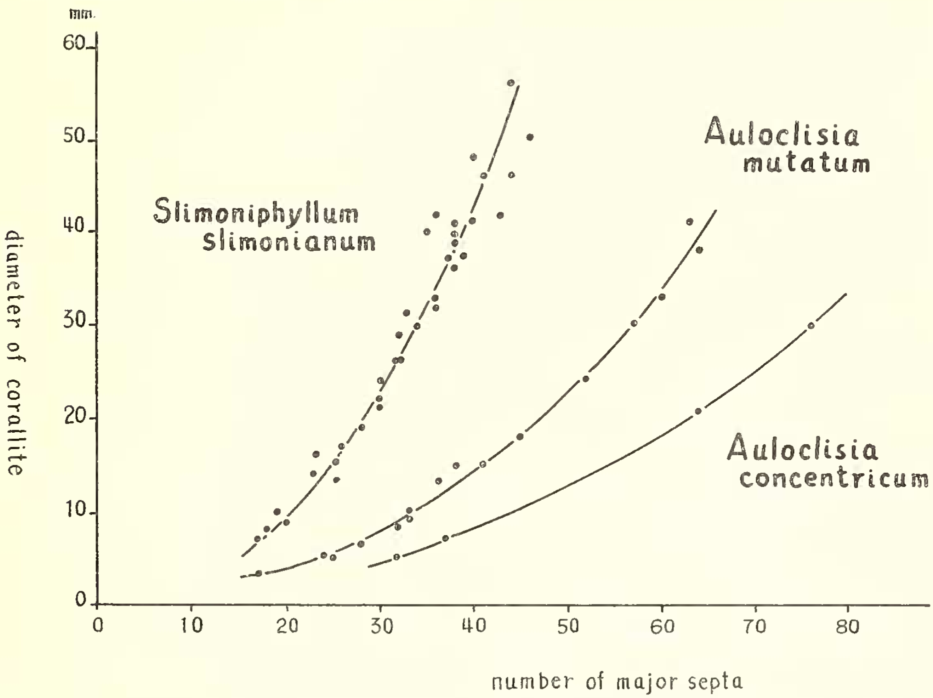
The tabularium is wide and in the young stages the tabulae are flat and complete. In the mature stages they are incomplete, widely spaced, and are inclined upwards against the axis, with a well-formed gutter at the outer end (GSM 64675J, Pl. 36, fig. 11). The width of the dissepimentarium varies considerably, and the dissepiments are moderately large and steeply inclined.

Ontogeny. Brephic stage: in all the corallites examined the tip is missing so that no brephic stage has been seen.

Early neanic stage: in the earliest stage seen (GSM 65275A, Pl. 35, fig. 1) the coral is of simple construction. The counter septum is already shortened and a simple columella is present. There are seventeen major septa at this stage and they are not thickened. The axial end of the septa fall short of the centre, leaving an open space around the columella. Minor septa and dissepiments are not yet developed.

The 3rd and 4th cycle of insertion of major septa marks the next stage when there are eighteen to twenty-two major septa. At this stage minor septa are beginning to be formed, and all the septa are becoming thickened (GSM 65275B, Pl. 35, fig. 2). Septal lamellae and tabellae are added to the columella and a small simple axial column is developed (GSM 65277C, Pl. 35, fig. 10; note the tabulae are here inclined downwards to the axis and are widely spaced).

Late neanic stage: dissepiments first develop at about the 4th or 5th septal insertion



TEXT-FIG. 9. Diagram showing the relationship between the number of major septa and the diameter of the corallite in *Slimoniphyllum slimonianum* (Thomson) and two related species.

(24–26 major septa), although in one case (GSM 65277) they do not appear until the 7th insertion. At this stage (4th or 5th insertion) both the cardinal and the counter fossulae are distinct. The axial column is differentiated from the tabularium and usually has a medial plate. All the septa are dilated in the tabularium and the minor septa are prolonged into that area. The stage at which the medial plate is lost differs from specimen to specimen, but the earliest case is when the number of major septa is thirty (GSM 65277). The minor septa tend to shorten with the growth of the corallite, but the stage at which they are confined to the dissepimental zone varies between the stage with thirty-four major septa and that with forty-six. After the 7th septal insertion (about thirty-five major septa) the septa start to become vesicular and small spaces appear between the dilated parts of the major septa and the medial line. This vesicular tendency increases with the growth of the corallite.

Adult stage: when the number of major septa is more than thirty-five, all the specific characters are attained and the corallite is considered to be mature. The axial structure tends to merge with the tabularium, the differentiation of the axis becomes less distinct, the medial plate is lost, and the septal lamellae are twisted. The vesicular tendency of the dilated major septa becomes prominent, and the minor septa are confined to the dissepimental zone which is well developed. The tabulae are incomplete and inclined upwards to the axial structure. The dissepiments are concentric during the early stages of development, but with the increase in the width of the corallite they tend to become irregular, angular, and of pseudo-herringbone type, especially at the inner margin of the dissepimentarium. Lonsdaleoid dissepiments first appear when the number of major septa is between forty-two and forty-six, with the exception of GSM 101891 in which they are formed when there are only thirty-three major septa.

The most advanced stage is seen when the caninomorphic features are developed. The lectotype (KM.T 1021) approaches this stage. In GSM 101891G the axial structure is entirely degenerate, and the tabulae are complete and flat. The septa remain dilated in the tabularium until the final stages, but in the calice all the septa are thin and of equal thickness and may be crenulate in the dissepimentarium (GSM 65277E).

The structure of the axial column can be divided for convenience into five stages, representing both a morphological and an ontogenetic series and is summarized thus:

A. Axial column not yet formed. Simple columella present and free from septa. Like young stage of *Auloclisia* and *Carcinophyllum*.

B. Medial plate present. Axial structure clearly differentiated from tabularium. Like *Cravenia*, *Auloclisia*, and *Clisiophyllum*.

C. Axial column composed of loose axial tabellae, several septal lamellae and occasionally a short medial plate. Column weakly differentiated from tabularium. Like *Auloclisia*. Example GSM 65287.

D. Tabulae incomplete, gently arched at centre of corallite where they make a weak axial structure together with several twisted lamellae. Like *Rodophyllum*. Example GSM 65275.

E. Tabulae complete and flat. Axial structure lost. Like *Caninia*. Example GSM 101891.

Variation. The general shape of the corallite may be trochoid or ceratoid. The trochoid form is represented by GSM 101891 and probably includes KM.T 1021 which is too incomplete to be definite. GSM 65277 is an example of the ceratoid form, to which most specimens belong. The convexity of the latter group is variable, with GSM 64611 less convex, and GSM 64675 much more convex than normal. The trochoid forms appear to have the strongest development of lonsdaleoid dissepiments and of the caninioid tendency, whereas the ceratoid types have more strongly developed axial structures.

The greatest variation among the internal characters is in the shape and size of the axial structure. Each individual passes through several stages during development, but the diameter at which a certain stage is reached varies greatly with the individual. The pattern in the mature corallite varies from type C to type E, A and B types only being present in immature sections. The different types, however, are developed earlier in some specimens than in others. In GSM 101891 the column already shows D type features when there are only thirty-seven major septa, whereas in GSM 64675 at this stage a B–C type column is developed.

The adult axial types are listed in the following table.

E type	GSM 101891.
D type	KM.T 1021. GSM 64611, 65275, 65276, 65286, 101892. BM.R 17321, 17322.
C type	GSM 65277, 65287, 65288, 65290, 65291.
B–C type	GSM 64675.

The vesicular tendency of the major septa develops when about thirty-five major septa are present, but although it starts at about the same time in most corallites, the degree of development is variable. In one specimen (GSM 65275) it occurs earlier than is normal, the vesicular tendency being weakly developed when the septal dilatation starts. But the spaces soon disappear and the tendency develops again at the normal stage. The vesicular tendency is most strongly developed in G.S.M. 101891 and KM.T 1021, both stratigraphically higher specimens.

Axially the major septa usually end bluntly, and are occasionally slightly clavate. But when the axial column becomes poorly differentiated, the axial portions of the septa taper and are joined to the septal lamellae (GSM 65287, 64611, 101891, and KM.T 1021).

Remarks and comparisons. In *Slimoniphyllum* the cardinal fossula is situated on the convex side of the corallite, the normal arrangement in most rugose corals. The position of the cardinal fossula is usually a stable character, but in *Dibunophyllum* and *Clisiophyllum*, which also have the cardinal fossula on the convex side, the reversed arrangement occurs in a few specimens. This suggests that the position of the cardinal fossula is not necessarily a genetic character, but may be an adaptation.

Both the cardinal septum and the counter septum are shortened in *Slimoniphyllum*. In *Auloclisia* Lewis, *Clisiophyllum* Dana, *Dibunophyllum* Nicholson and Thomson, *Koninckophyllum* Thomson and Nicholson, and *Caninia* Michelin, however, only the cardinal septum is shortened, and the counter septum is the same length as, or even longer than, the other major septa. The shortening of the counter septum is not unique to *Slimoniphyllum*, also being a characteristic feature of *Cryptophyllum* Carruthers and *Rhopalolasma* Hudson. But it is rare among corals with a dissepimental zone, and only three examples have been noted in British Carboniferous corals. Very slight shortening of the counter septum is seen in one calicular section of *Clisiophyllum ingletonense* Vaughan (GSM 65070), and in the mature sections of *Auloclisia mutatum* Lewis (1927, pl. 2, fig. 1). In *Caninia buxtonensis* Lewis, a species based on a single specimen, the counter fossula is prominent (Lewis 1924, pl. 30, fig. 3*d*). *A. mutatum* is closest to *S. slimonianum* and the very slight shortening of the counter septum in mature sections of *Auloclisia* is here considered to be a transitional feature linking *Auloclisia*, which is confined to D_1, and *Slimoniphyllum*, which occurs in D_2.

The typical axial structure of *S. slimonianum* is of the *Rodophyllum* type, in which the cobweb-like axial column has lost its medial plate and the septal lamellae are twisted. This type is known in several Carboniferous corals, and possibly represents a trend. *Rodophyllum* (= *Dibunophyllum* of the *bipartitum craigianum* subspecies group) and *Auloclisia* are both distinguished by this type of axis, and the trend is also recorded in *Cravenia lamellata* Howell. In many of these forms the column retains its general outline after the degeneration of the medial plate, but in *Slimoniphyllum*, degeneration continues until the column is completely lost. Similar cases of the degeneration of the axial column have been described by Vojnovsky-Krieger (1956) with a gradual change from a *Cyathoclisia*-like form, through a Koninckophylloid form to a Caninioid form: and Hudson and Anderson (1928) also recorded a Caninioid stage in the late ontogenetic stage of *Hettonia fallax*.

The vesicular type of septal development of *S. slimonianum* has also been observed in